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THE ROCKFISHES, GENUS *SEBASTES* (SCORPAENIDAE), OF THE GULF OF CALIFORNIA, INCLUDING THREE NEW SPECIES, WITH A DISCUSSION OF THEIR ORIGIN

By

Lo-chai Chen

Department of Zoology, San Diego State University, San Diego, California 92182

ABSTRACT: Seven species of *Sebastes*, herein described and compared, occur in the Gulf of California at the near-tropical fringe of the range of the genus in the northeastern Pacific. Six of the species are endemic to the Gulf. Three of these, (*S. spinorbis*, *S. varispinis*, and *S. peduncularis*) are described as new. Only *S. macdonaldi* occurs also on the outer coast of Baja California.

Sebastes sinensis and *S. cortezi* are mesopelagic as well as benthic. *Sebastes cortezi*, like *S. diploproa* of the outer coast, inhabits floating vegetation as prejuvenile; it undergoes extreme morphological change on leaving its surface habitat.

The distribution pattern of these seven species seems to be related to water temperature and dissolved-oxygen level.

Multiple invasion from the outer coast and subsequent radiation within the Gulf may both have contributed to the species diversity within the Gulf. *Sebastes diploproa* of the outer coast probably came from reciprocal invasion by *S. cortezi* from the Gulf.

INTRODUCTION

The rockfish genus *Sebastes* is represented by many species in the North Pacific. Only a few others are known from the North Atlantic and from the southern hemisphere. Chen (1971) listed 65 species of the genus for the American coast of the North Pacific. Since then there have been three additions: *S. borealis* Barsukov (1970), *S. variegatus* Quast (1971), and *S. rufinanus* Lea and Fitch (1972).

The first species of *Sebastes* recorded from the Gulf of California were described as *Sebastichthys sinensis* in 1890 and *Scorpaenodes cortezi* in 1938. Lavenberg and Fitch (1966) reported specimens from the Gulf but did not assign species names. The next record was that of Chen (1971), who reported the occurrence of *S. macdonaldi* and described *S. exsul* from the Gulf. I here report seven species from the Gulf, of which three are described as new (two of these three were included, but not specifically named, in my 1971 list of 65 American North Pacific species).

With these additions, with another new species to be described by Lea and Fitch (personal communication), and with the placement of *S. vexillaris* in the synonymy of *S. caurinus* (Chen, in preparation), the number of known species of *Sebastes* in the eastern North Pacific is now 69.

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METHODS

The terminology and methods in this report follow those of Chen (1971).

Abbreviations for the listed collections are: CAS, California Academy of Sciences; LACM, Los Angeles County Museum; SDSC, San Diego State University; SIO, Scripps Institution of Oceanography; UCLA, University of California, Los Angeles.

KEY TO THE ROCKFISHES, GENUS *SEBASTES*, OF THE GULF OF CALIFORNIA

1a Lower edge of lachrymal with three or four small, spinelike projections; lateral-line pores more than 50; second anal spine shorter than third; lateral surface of lachrymal with a spine in specimens longer than 10 cm. (fig. 1a) ..... *S. macdonaldi*

1b Lower edge of lachrymal with only two projections which may be spinelike and sometimes split; lateral-line pores fewer than 50; second anal spine longer than third; lateral surface of lachrymal without a spine (except in *S. spinorbis*) 2

2a Supraocular spines present 3

2b Supraocular spines absent 4

3a Lateral surface of lachrymal and/or orbital edge of first and/or second suborbital with spines; P_1 18; rakers on first gill arch 29–33 (fig. 1b) ..... *S. spinorbis*

3b Lateral surface of lachrymal and orbital edge of first and second suborbitals without spines; P_1 17; rakers on first gill-arch 32–37 (fig. 1c) ..... *S. exsul*

4a Scales mostly cycloid, occasionally with weakly developed ctenii; dorsal soft-rays more often 11 than 12 (mouth and gill-cavity linings dusky in specimens 4 or 5 cm. long, jet-black in larger ones; ventral lachrymal projections pointing backward; rakers on first gill-arch 29–33) (figs. 1d and 2b) ..... *S. sinensis*

4b Scales mostly ctenoid, with ctenii evident in specimens 4 or 5 cm. long; dorsal soft-rays more often 12 than 11 5

5a Mouth and gill-cavity linings black; lower jaw slightly projecting; dorsal spines sometimes 12 (20%); (rakers on first gill-arch 30 or more) (fig. 2a) ..... *S. varispinis*[1]

5b Mouth and gill-cavity linings may be dusky, never black; jaws subequal; dorsal spines almost always 13 6

6a Head width in S.L. 6.5 or less; (rakers on first gill-arch 30 or fewer; anterior lachrymal projection directed forward in specimens longer than 6 cm.) (figs. 1e, 2c, and 2d) ..... *S. cortezi*

6b Head width in S.L. more than 6.5 (fig. 2e) ..... *S. peduncularis*[1]

Sebastes exsul Chen, 1971.

(Figure 1c.)

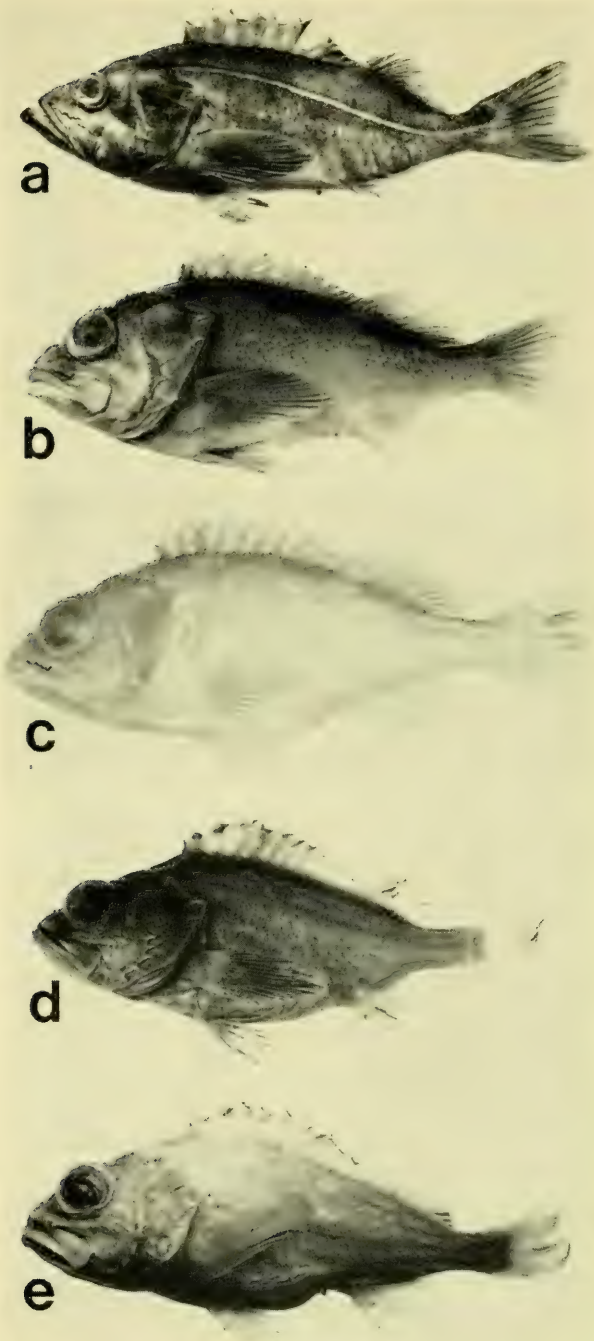
Sebastes exsul CHEN, 1971, p. 27 (type locality: Gulf of California, at 28° 59′ N., 113° 25.5′ W.)

DIAGNOSIS. *Sebastes exsul* can be differentiated from all other species of *Sebastes* by the following combination of characters: (1) the color pattern of the subgenus *Sebastomus* (body pink or red, with white blotches at tip of opercle, bases of fourth, eighth, and last dorsal spines and last dorsal ray, and also one below ninth dorsal spine just above lateral line); (2) the cranial spine pattern (with nasal, preocular, supraocular, postocular, tympanic, and parietal spines); (3) the meristics (D. XIII, 12–13; A. III, 6; P_1 17; rakers on first gill-arch 32–37; lateral-line pores 35–43); (4) a nearly vertical anal profile; (5) a narrow interorbital divided by frontal ridges into three grooves; (6) the oral and the gill-cavity linings white; (7) subequal jaws; (8) scaled mandibles; (9) short dorsal spines (orbit length in fourth dorsal spine less than 1.2); and (10) absence of spines on the lateral surface of lachrymal and the orbital edge of the first and second suborbitals.

DESCRIPTION. A detailed description was given by Chen (1971) and is supplemented here.

Principal caudal rays 14; vertebrae (in 8 specimens) 26 (11 + 15). Each one of the two extrinsic gas-bladder muscles (2 specimens examined) extends backward from an origin on or near the opisthotic, passes medial to the cleithrum to which it has a membranous connection, then splits into three tendons which pass between the second and third ribs, running straight along the inner side of succeeding ribs and inserting respectively on the parapophyses of the 7th, 8th, and 9th centra. The last tendon is split in one specimen, with the additional branch attached to the parapophysis of the 10th centrum. There is no direct connection between the tendons and the gas-bladder wall.

[1] 3–5 cm. juveniles only.


a
b
c
d
e

For morphometrics and meristics, see tables 1, 7, 8, and 9.

REMARKS. This species is most likely to be confused with *S. umbrosus*, *S. rosenblatti*, and *S. spinorbis*. It can be distinguished from *S. umbrosus* by its lack of the conspicuous honeycomblike color pattern, from *S. rosenblatti* by its higher average number of gill rakers, and from both by its short dorsal spines. From *S. spinorbis*, *S. exsul* can be distinguished by the lack of spines on the lateral surface of the lachrymal and the orbital edge of the first and second suborbitals, by having only 17 pectoral rays, by having more rakers on the first gill-arch (32–37 instead of 29–33), by lacking spines on the lower edge of the gill-cover, and by having clear fin membranes and white oral and gill-cavity linings.

Since describing the species in 1971, I have acquired 21 additional specimens, all from the type locality. Of these specimens, one (SIO 69-437, 180 mm.) resembles *S. spinorbis* in having a spine on the lateral surface of each lachrymal, but it is regarded as *S. exsul* because the spine is weak and because it agrees with *S. exsul* in having 16–17 pectoral rays, 33–34 rakers on the first gill-arch, no spines on the lower edge of gill-cover, the fin membranes clear, and the oral and the gill-cavity linings white.

RANGE. Known only from the vicinity of the type locality, 28° 59′ N., 113° 25.5′ W.

MATERIAL EXAMINED. A total of 36 specimens, 150–212 mm.

Holotype. SIO 68-1, 171 mm., adult female, from 28° 59′ N., 113° 25.5′ W., 2.5 miles N. of Punta Roja, Bahía de los Angeles.

Paratypes. All from vicinity of the type locality. SIO 62-241, 7 (158–212); SIO 68-3, 7 (150–202).

Other specimens. All from vicinity of the type locality. SIO 69-318, 12 (170–188); SIO 69-437, 14 (156–197); CAS 17605, 1 (184).

Sebastes spinorbis Chen, new species.
(Figure 1b.)

DIAGNOSIS. *Sebastes spinorbis* can be differentiated from all other species of *Sebastes* by the following combination of characters: (1) the color pattern and the cranial spine pattern of the subgenus *Sebastomus* (see diagnosis of *S. exsul*); (2) presence of a spine on the lateral surface of the lachrymal and or the orbital edge of the first and second suborbitals; (3) 18 pectoral rays; (4) 29–33 gill-rakers; and (5) dusky to black pectoral membrane.

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FIGURE 1. a). *Sebastes macdonaldi*, adult male, 412 mm., SDSC 74-12. b). *S. spinorbis*, holotype, adult male, 225 mm., SIO 69-318. c). *S. exsul*, holotype, adult female, 171 mm., SIO 68-1. d). *S. sinensis*, adult female, 149 mm., LACM 30065-1. e). *S. cortezi*, adult female, 207 mm., LACM 33939-1.

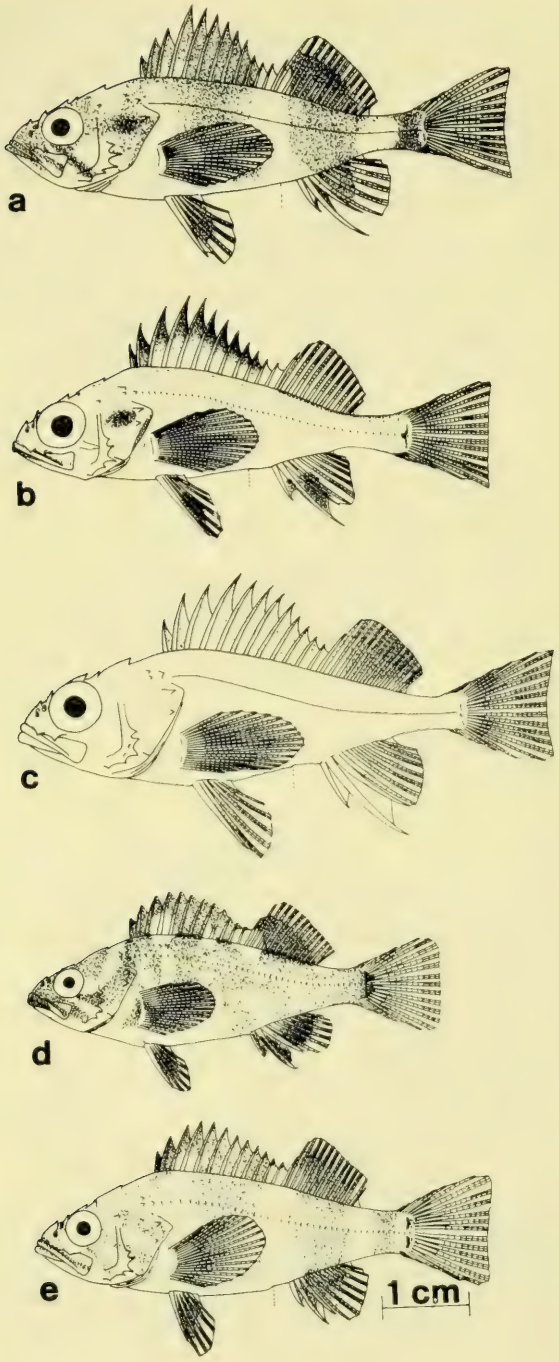
a
b
c
d
e
1 cm

TABLE 1. *Morphometrics (standard length/body part measurement) of* Sebastes exsul *and* Sebastes varispinis. *Characters are in sequence as given for the subgenus* Sebastomus *by Chen (1971), with the most frequently negatively allometric one placed above and the most frequently positively allometric one placed below. "+" means significant positive allometry and "–" means significant negative allometry.*

Character	size range, mm. no.	*S. exsul* 151–212 36	*S. varispinis* 33–53 20
2nd anal spine		5.1 – 6.3	4.3 – 5.5
Gill-raker at angle		18 – 31	15 – 21
3rd anal spine		6.1 – 7.6	5.6 – 7.5
2nd dorsal soft-ray		5.7 – 6.9	5.1 – 7.4
1st anal spine		10.0 –12.8	8.4 –11.3
Orbit length		7.1 – 8.4	8.4 –10.0
Total length		0.81– 0.84	0.80– 0.83
4th dorsal spine		6.6 – 8.1	4.6 – 6.2
1st anal soft-ray		4.7 – 5.4	5.0 – 6.2
Anal-fin base		6.6 – 8.1	5.9 – 7.5
Pelvic-fin length		4.1 – 4.9	4.2 – 4.9
Predorsal length		2.5 – 2.8	2.8 – 3.2
Pectoral-fin length		3.1 – 3.7	3.3 – 3.8
Lower peduncle length		4.8 – 5.6	4.8 – 5.9
Soft-dorsal base		4.4 – 5.0	4.1 – 5.1
Dorsal-fin incision		12 – 16	7.6 –13.8
Caudal-peduncle depth		9.5 –11.2	10.2 –11.6
Upper peduncle length		6.6 – 8.4	6.2 – 7.6
Spinous-dorsal base		2.5 – 2.9	2.8 – 3.3
Snout length		8.7 –11.4 (+)	11.0 –13.2
Prepelvic length		2.1 – 2.5 (+)	2.3 – 2.7
Head length		2.3 – 2.4 (+)	2.6 – 3.0
Upper-jaw length		4.6 – 5.1 (+)	5.6 – 6.8
Preanal length		1.4 – 1.5	1.4 – 1.5
Body depth		2.4 – 2.8 (+)	3.2 – 3.6
Head width		4.6 – 5.4 (+)	6.3 – 8.0
Lachrymal width		27 – 38	50 – 62
Interorbital width		13 – 17 (+)	14 – 16

DESCRIPTION. D. XIII, 13–14; A. III, 6; P_1 18 (16–18); C. 14; rakers on first gill-arch 29–33 (9–10 + 20–23); lateral-line pores 33–41; vertebrae (in 4 specimens) 26 (11 + 15).

Base of skull straight. Interorbital concave, divided by frontal ridges into

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FIGURE 2. a). *Sebastes varispinis*, holotype, subsurface juvenile, 49 mm., LACM 8821-11. b). *S. sinensis*, juvenile, 46 mm., LACM 30064-3. c). *S. cortezi*, transformed juvenile, 51 mm., SIO 68-90. d). *S. cortezi*, surface prejuvenile, 38 mm., SIO 62-239. e). *S. peduncularis*, holotype, juvenile, 43 mm., LACM 8818-6.

three grooves. Nasal, preocular, supraocular, postocular, tympanic, parietal, and, frequently, nuchal spines present, sharp, and strong. Parietal ridges well developed, elevated. Lower edge of gill-cover where interopercular and subopercular meet often with one or two spines. Preopercular spines equally spaced, the upper two directed backward, the lower two or three downcurved. Lachrymal projections two, spinelike, directed backward, sometimes bifurcate; lateral surface of lachrymal above and between lachrymal projections and orbital edge of first and second suborbitals each often bearing a sharp, backward-directed spine. Supracleithral, cleithral, and the two opercular spines well developed.

Symphyseal knob round, directed downward; jaws subequal. Maxillary reaching to vertical from posterior edge of orbit.

Scales ctenoid. Upper and lower lips and snout between and before nasal spines scaleless; branchiostegals with or without scales, head scaled elsewhere. Fin rays scaled; fin membranes scaled basally, most extensively on anal and caudal.

Dorsal spines increasing in length to 4th, then decreasing gradually to 12th, 13th spine longer than 12th; soft dorsal high, with the short posterior rays when depressed reaching to about midpoint of caudal peduncle. Second anal spine stronger and longer than third, its tip extending to about two-thirds the length of first anal soft-ray when depressed; tips of posterior anal soft-rays, when depressed, exceeded by tips of anterior anal soft-rays. Profile of anal nearly vertical. Caudal truncate. Origin of pectoral below third or fourth dorsal spines; pectoral pointed, with longest ray (usually 11th) notably longer than adjacent rays; pectoral extending beyond tip of pelvic to above anus. Origin of pelvic below 4th dorsal spine; tip of pelvic reaching to anus or falling short by one-fifth of pelvic-to-anal distance. Origin of anal below 3rd or 4th dorsal soft-ray, insertion of anal below 9th to 11th dorsal soft-ray.

Extrinsic gas-bladder muscles (one paratype examined) as in *S. exsul*.

Color in life pink to red. Body with six white blotches as in *S. exsul*. Dark green dusky patches on top and sides of head, above lateral line, and along basal part of dorsal fin, those on the back sometimes disrupted into vermiculations. Fins pink, conspicuously dusky on membranes of pectoral, soft-dorsal, and caudal. Scales on side of body with dusky margin. Gill cavity and mouth lining dusky. Peritoneum blackish. In preserved condition dusky marks become black and pink or red fade.

For morphometrics and meristics, see tables 2, 7, 8, and 9.

ETYMOLOGY. The name *spinorbis*, from the Latin, refers to the spines along the lower edge of the orbit.

DISCUSSION. Because only four specimens are available and because the several distinguishing characteristics are subject in the genus to some variation, it is difficult on the basis of single characters to differentiate *S. spinorbis* from *S. exsul*. The spine on the lateral surface of lachrymal, although not found

TABLE 2. *Morphometrics (standard length/body part measurement), meristics ("*" signifies left and right counts), and head spines of* Sebastes spinorbis.

Character	Holotype	Paratypes		
	SIO 69-318	SIO 69-437	CAS 30689	
Standard length (mm.)	225	259	241	213.5
Morphometrics:				
2nd anal spine	5.9	5.9	5.9	5.6
Gill-raker at angle	27	24	25	25
3rd anal spine	6.4	6.9	6.4	7.1
2nd dorsal soft-ray	5.9	6.5	6.1	6.0
1st anal spine	11.1	11.2	11.0	11.4
Orbit length	8.7	8.2	8.7	8.1
Total length	0.83	0.83	0.83	0.81
4th dorsal spine	8.0	7.9	7.7	7.4
1st anal soft-ray	4.6	5.0	4.7	4.7
Anal-fin base	7.5	7.6	7.5	7.4
Pelvic-fin length	4.2	4.5	4.2	4.2
Predorsal length	2.7	2.6	2.6	2.6
Pectoral-fin length	3.3	3.4	3.1	3.3
Lower peduncle length	5.2	5.8	5.1	5.3
Soft-dorsal base	4.8	4.8	4.8	4.5
Dorsal-fin incision	15.3	15.0	15.8	14.6
Caudal-peduncle depth	9.9	10.4	9.9	9.7
Upper peduncle length	7.6	8.0	7.7	7.3
Spinous-dorsal base	2.7	2.8	2.7	2.7
Snout length	10.1	10.0	9.2	9.7
Prepelvic length	2.6	2.4	2.5	2.4
Head length	2.4	2.3	2.3	2.3
Upper-jaw length	4.8	4.4	4.7	4.6
Preanal length	1.40	1.34	1.41	1.39
Body depth	2.6	2.4	2.6	2.5
Head width	4.6	4.1	4.5	4.3
Lachrymal width	30	30	28	30
Interorbital width	15	14	13	16
Meristics:				
Lateral-line pores *	38–38	37–36	33–35	41–40
Dorsal soft-rays	13	14	13	13
Pectoral rays *	18–18	18–18	18–18	16–18
Anal soft-rays	6	6	6	6
Gill-rakers *	30–31	31–32	33–32	29–29
Head spines *:				
Nuchal	1–1	0–0	0–1	0–0
Edge of lower gill cover	2–2	1–0	2–2	2–2
Lateral surface of lachrymal	1–1	1–1	1–1	0–1
Orbital edge of 1st suborbital	0–1	0–0	1–0	0–0
Orbital edge of 2nd suborbital	1–1	0–0	0–0	0–0

in any other species of subgenus *Sebastomus*, is variably present in *Sebastiscus marmoratus* (personal data), and does not develop in *Sebastes macdonaldi* until the fish reaches 10 cm. The spines along the orbital edge of the first and second suborbitals develop only in adults in *Sebastes aleutianus*. The higher pectoral-ray count (significantly different from that of *S. exsul* at 0.01 level, rank-sum test), the lower gill-raker number (significantly different from that of *S. exsul* at 0.002 level, rank-sum test), the presence of spine(s) on lower edge of gill cover, and the dusky fin membranes, all are variable and overlap with *S. exsul*. The separation of the two species is based on: (1) the non-obligatory correlation of the above characters (higher pectoral-ray count and wider pectoral base, or larger eye and narrower lachrymal would be obligatorily correlated); (2) the larger size of the specimens of *S. spinorbis*; and (3) the co-occurrence of the two forms (taken at the same stations from the same depths.)

MATERIAL EXAMINED. Four specimens, 214–259 mm., two males and two females, all mature, but with gonads in resting stage.

Holotype. SIO 69-318, 225 mm., male, from 28° 58.5′ N., 113° 26.5′ W., 2.5 miles NE. of Punta Rojas, Bahía de los Angeles, collected by hook and line from bottom at 130–160 m., by H. G. Moser on 29 April 1969.

Paratypes. All from the type locality at depths between 130–160 m. SIO 69-437, 1 (259); CAS 30689, 2 (214–241).

Sebastes sinensis (Gilbert, 1890).

(Figures 1d and 2b.)

Sebastichthys sinensis GILBERT, 1890, p. 81 (type locality: *Albatross* Station 3015, at 29° 19′ 00″ N., 112° 50′ 00″ W.).

Pteropodus sinensis: EIGENMANN & BEESON, 1893, p. 670 (relationships); 1894, p. 397 (species analysis).

Sebastodes sinensis: CRAMER, 1895, p. 600 (species analysis). JORDAN & EVERMANN, 1896, p. 431 (placed in subgenus *Hispaniscus*); 1898, pp. 1776 & 1813 (key and description). HUBBS, 1951, p. 129 (designated as type species of subgenus *Allosebastes*).

Hispaniscus sinensis: JORDAN, EVERMANN, & CLARK, 1930, p. 368 (name only).

Sebastes sinensis: CHEN, 1971, pp. 63 & 77 (meristics and distribution).

REMARKS. M'Clelland (1843) described *Sebastes sinensis* from China. The '*sinensis*' of M'Clelland is now considered to be a junior synonym of *Sebastiscus marmoratus* and is not to be confused with the present species. Since the '*sinensis*' of Gilbert has been placed into the genus *Sebastes* previously (Chen, 1971), according to the subsection (ii) added in 1972 to the Article 59 (b) of the International Code of Zoological Nomenclature, the '*sinensis*' of Gilbert is not to be rejected for its secondarily homonymous condition.

DIAGNOSIS. *Sebastes sinensis* can be differentiated from all other species of *Sebastes* by the following combination of characters: (1) the cranial spine pattern (with sharp nasal, preocular, postocular, tympanic, parietal, and occasionally nuchal spines); (2) the meristics (D. XIII, 11 (11–13); A. III,

5–6; P_1 18 (17–19); rakers on first gill-arch 29–33); (3) division of the interorbital by frontal ridges into three shallow grooves; (4) sharp, spinelike, backward-directed lachrymal projections; (5) the oral and the gill-cavity linings jet-black; and (6) predominantly cycloid rather than ctenoid squamation.

Description. D. XIII, 11 (11–13); A. III, 6 (5–6); P_1 18 (17–19); C. 14; rakers on first gill-arch 29–33 (8–10 + 20–23); lateral-line pores 38–43 (36–46); pyloric caeca (in 6 specimens) 9–12; vertebrae (in 25 specimens) 26 (11 + 15).

Base of skull straight. Interorbital concave, divided by frontal ridges into three shallow grooves. Nasal, preocular, postocular, tympanic, parietal, and occasionally nuchal spines present, sharp, and moderately strong. Parietal ridges well developed and elevated. Lower edge of gill-cover spineless. Upper three or four preopercular spines parallel, pointing straight backward or obliquely upward, lower one or two preopercular spines tend to point downward and be more widely spaced. Lachrymal projections two, spinelike, directed backward, occasionally bifurcate. Supracleithral, cleithral, and the two opercular spines well developed.

Symphyseal knob inconspicuous in small specimens, directed downward in large ones; jaws subequal. Maxillary ending behind vertical from posterior edge of pupil but before margin of orbit.

Most scales cycloid, occasionally with weakly developed ctenii. Lips and snout between and before nasal spines scaleless; mandibles and maxillaries scaleless or rarely with patches of fine scales, skin smooth to touch; branchiostegals scaleless; head scaled elsewhere. Fin rays scaled; fin membranes scaled basally, most extensively on anal and caudal.

Dorsal spines increasing in length to 4th, then decreasing gradually to 12th, 13th spine longer than 12th; soft dorsal high, with the short posterior rays when depressed reaching to near midpoint of caudal peduncle. Second anal spine stronger and longer than third, its tip often reaching to or beyond tip of first anal soft-ray when depressed; tips of posterior anal soft-rays, when depressed, exceeded by tips of anterior anal soft-rays Profile of anal nearly vertical. Caudal truncate. Origin of pectoral below 3rd or 4th dorsal spines; margin of pectoral fin rounded, 9th to 11th rays longest; pectoral extending beyond tip of pelvic to above anus. Origin of pelvic below 4th or 5th dorsal spine; tip of pelvic reaching to anus (small specimens) or falling short by one-fourth of pelvic-to-anal distance (large specimens). Origin of anal below 4th or 5th dorsal soft-ray, insertion of anal below 9th to 10th dorsal soft-ray.

Extrinsic gas-bladder muscles (7 specimens examined) as in *S. exsul*, except that each muscle sometimes splits into only two instead of three tendons, inserting respectively on parapophyses 8 and 9, 9 and 10, or 8, 9, and 10.

Color in life pink or red, with light to heavy dusky patches on back and sides. Membranes of the edge of spinous dorsal and distal part of pectoral

Table 3. *Morphometrics of* Sebastes sinensis. *Explanations as table 1.*

Character	size range mm. / no.	44–49 / 6	51–99 / 25	102–152 / 27
2nd anal spine –		3.8 – 4.4	3.6 – 4.5	4.1 – 5.2
Gill-raker at angle –		18 – 23	17 – 23	18 – 32
3rd anal spine –		4.8 – 5.7	4.7 – 5.6	4.8 – 5.8
2nd dorsal soft-ray –		5.0 – 5.8	5.1 – 6.2	5.5 – 6.5
1st anal spine		8.8 –10.8	8.2 –10.9	8.4 –11.5
Orbit length +		6.9 – 7.3	6.8 – 8.1	6.3 – 8.1
Total length –		0.78– 0.81	0.79– 0.83	0.80– 0.84
4th dorsal spine –		4.4 – 5.2	4.1 – 5.3	4.6 – 5.6
1st anal soft-ray		4.7 – 5.9	4.7 – 5.7	4.6 – 5.5
Anal-fin base –		5.9 – 7.3	6.3 – 7.6	6.7 – 8.8
Pelvic-fin length –		4.1 – 4.5	4.0 – 4.5	4.1 – 4.7
Predorsal length		2.6 – 2.7	2.6 – 2.8	2.5 – 2.9
Pectoral-fin length –		3.4 – 3.6	3.2 – 3.7	3.2 – 3.8
Lower peduncle length –		4.9 – 5.5	4.8 – 5.8	5.1 – 6.2
Soft-dorsal base		4.7 – 5.4	4.4 – 5.8	4.4 – 5.6
Dorsal-fin incision –		7.0 – 8.0	6.4 – 9.9	7.7 –10.1
Caudal-peduncle depth		11.4 –12.5	10.8 –13.1	10.2 –13.1
Upper peduncle length –		6.7 – 7.5	6.2 – 7.5	6.6 – 8.0
Spinous-dorsal base		2.7 – 3.0	2.6 – 3.0	2.6 – 3.2
Snout length +		11.6 –13.0	10.5 –12.4	9.8 –11.8
Prepelvic length +		2.4 – 2.6	2.4 – 2.7	2.3 – 2.6
Head length +		2.4 – 2.5	2.4 – 2.5	2.3 – 2.5
Upper-jaw length +		5.3 – 5.8	5.0 – 5.7	4.8 – 5.6
Preanal length +		1.5	1.4 – 1.5	1.3 – 1.4
Body depth +		3.0 – 3.2	2.7 – 3.3	2.7 – 3.1
Head width +		5.6 – 6.6	5.4 – 6.6	5.0 – 6.5
Lachrymal width +		46 – 53	41 – 52	39 – 52
Interorbital width +		16 – 17	15 – 19	14 – 17

relatively clear in juveniles but becoming conspicuously black in adults; other fin membranes dusky over pink. Specimens in alcohol pale, with dusky to black patches on the back and on various fin membranes and on the edge of the dorsal. Peritoneum and oral and gill-cavity linings jet-black.

For morphometrics and meristics, see tables 3, 7, 8, and 9.

Range. The range of this species is rather limited. In spite of the numerous collections, *S. sinensis* is definitely known only within a range of about one degree square (28° 35′ to 29° 49′ N., 112° 50′ to 113° 59′ W., see Material examined). The only exception is from a questionable record (CAS SU 123, 31° 22′ N., 114° 07′ 45″ W., 34 m., 18.4° C., 25 March 1889).

Size. *S. sinensis* is a small fish. Females as small as 99 mm., collected 18 January 1968, carry eyed embryos. The largest female examined measures 152 mm. and the largest male 147 mm.

Depth. Most specimens examined were collected with otter trawls at depths ranging from 290 m. to 654–670 m. Some of the specimens, however, were collected with midwater trawls far above the bottom (in one case at a depth of less than 500 m. where the bottom is at 1400 m. The circumstance that these specimens, both juveniles and adults, possess characteristics not normal to epipelagic prejuveniles of *Sebastes*, indicates that *S. sinensis* occurs mesopelagically.

Material examined. A total of 102 specimens from 46 to 150 mm.

Holotype. USNM 43085, 150 mm., adult male, from *Albatross* Station 3015, 29° 19′ 00″ N., 112° 50′ 00″ W., 290 m.

Other material. SDSC 72-28, 10 (59–133), 29° 48.7′ N., 113° 57.2′ W. SIO 68-89, 5 (104–135), 29° 43.9′ N., 113° 58.0′ W. to 29° 40.2′ N., 113° 55.4′ W. SIO 68-90, 26 (94–149), 29° 39.5′ N., 113° 55.5′ W. to 29° 43.5′ N., 113° 59.0′ W. SIO 68-102, 5 (55–62), 29° 00.5′ N., 113° 17.5′ W., to 28° 56.1′ N., 113° 12.1′ W., to 28° 47.4′ N., 113° 08.0′ W. LACM 8821-12, 5 (58–117), 28° 58′ N., 113° 11.4′ W. LACM 8818-8, 12 (106–156), 28° 55′ N., 112° 50.5′ W. LACM 30064-3, 14 (46–128), 28° 46′ 45″ N., 113° 06′ 00″ W., to 28° 35′ 36″ N., 112° 52′ 56″ W. LACM 30065-1, 22 (47–148), 28° 35′ N., 112° 52′ W., to 29° 03′ 00″ N., 113° 21′ 30″ W. CAS SU 123, 1 (119), *Albatross* Station 3026 (31° 22′ N., 114° 07′ 45″ W.).

Sebastes cortezi (Beebe and Tee-Van).

(Figures 1e, 2c, and 2d.)

Scorpaenodes cortezi Beebe & Tee Van, 1938, p. 304 (type locality: 24° 55′ N., 110° 20′ W.).

Sebastes cortezi was first described on the basis of suface-living prejuveniles. In the original description the species was assigned to the genus *Scorpaenodes* because of the poorly developed palatine teeth in the type. The pointed posterior end of the suborbital stay, however, indicates clearly that the species is of the genus *Sebastes*, and it was so listed by Chen (1971).

Diagnosis. The combination of the cranial spine pattern (with sharp nasal, preocular, postocular, tympanic, parietal, and occasionally nuchal spines) and the forward direction of the spinous lachrymal projection in adults differentiates this species from all other species of the genus except *S. diploproa*. This species is most similar to *S. diploproa* and *S. sinensis*. It differs from the former in lacking dentigerous knobs and a conspicuous symphyseal knob and in having fewer rakers on the first gill-arch (31 or fewer). From *S. sinensis* it differs in having an anteriorly directed, spinelike lachrymal projection, a dusky rather than jet-black gill-cavity lining, ctenoid rather than cycloid scales, and more often 12 rather than 11 dorsal soft-rays.

Surface-living prejuveniles of *S. cortezi* can be distinguished from those of other species of *Sebastes* by the following combination of characters: (1)

the cranial spine pattern (with skin-covered and therefore blunt-looking spines); (2) flat or slightly concave interorbital with inconspicuous frontal ridges; (3) the meristics (D. XIII, 12 (11–12); A. III, 6 (5–6); P_1 18 (17–19); rakers on first gill-arch 27–31); (4) small eyes (8.4–10.0 in SL in 28–43 mm. specimens); and (5) a distinctive color pattern (fig. 2d).

Description. D. XIII, 12 (11–12); A. III, 6 (5–6); P_1 18 (17–19); C. 14; rakers on first gill-arch 27–31 (8–10 + 18–22), with the first 3–8 rakers on each limb of first arch often rudimentary; lateral-line pores 33–45; pyloric caeca (in 3 specimens) 9–10; vertebrae (in 33 specimens) 26 (11 + 15).

Base of skull straight. Nasal, preocular, postocular, tympanic, parietal, and occasionally nuchal spines present. Parietal ridges well developed and elevated. Lower edge of gill-cover spineless. Supracleithral, cleithral, and both opercular spines well developed.

Symphyseal knob inconspicuous; jaws subequal. Maxillary ending behind vertical from posterior edge of pupil but before margin of orbit.

Scales ctenoid. Lips and snout between and before nasal spines scaleless; mandibles and maxillaries scaleless or with patches of fine scales, skin smooth to touch; branchiostegals scaleless; head scaled elsewhere. Fin rays scaled; membranes scaled basally, most extensively on anal and caudal.

Dorsal spines increasing in length to 4th or 5th, then decreasing gradually to 12th, 13th spine longer than 12th; soft dorsal high, with the short posterior rays when depressed reaching to only about midpoint of caudal peduncle. Second anal spine stronger and longer than third, its tip reaching to tip (transformed juveniles) or falling short by one-fourth of the length (surface-living prejuveniles and large adults) of first anal soft-ray when depressed. Caudal truncate. Origin of pectoral below 2nd or 3rd dorsal spine; margin of pectoral fin rounded, 9th to 11th rays longest; pectoral extending beyond tip of pelvic to near anus. Origin of pelvic below 3rd or 4th dorsal spine; tip of pelvic reaching to anus (transformed juveniles) or falling short by one-fourth of pelvic-to-anal distance (surface-living prejuveniles and large adults). Origin of anal below 2nd dorsal soft-ray, end of anal below 10th to 11th dorsal soft-ray.

Extrinsic gas-bladder muscles (4 specimens examined) as in *S. exsul*, except that each muscle splits variably into three to six tendons, with variable insertions. Of the four specimens examined, the tendons insert on parapophyses 8, 9, 10; 4, 6, 7, 8; 4, 6, 7, 8, 9; and 5, 6, 5, 6, 7, 8 respectively.

In other respects the surface-living prejuveniles differ from the transformed stages that live below the surface. The interorbital is flat rather than being concave and divided by frontal ridges into three grooves. Cranial and fin spines are so well covered with skin to appear blunt, rather than being superficially sharp. The preopercular spines are spaced equally and radiate, rather than having the two upper ones directed backward and the three lower ones downcurved. The two lachrymal projections are blunt rather than becoming spine-

Table 4. *Morphometrics of* Sebastes cortezi. "*" *signifies significant difference (analysis of covariance, $P < .005$) between prejuveniles and transformed specimens. Other explanations as table 1.*

	Prejuveniles	Transformed specimens			
size range mm.	28–40	51–91	104–144	160–198	208–255
Character no.	20	4	5	4	2
2nd anal spine * –	5.8 – 8.1	4.0 – 5.0	4.4 – 5.9	5.1 – 6.4	5.9 – 6.9
Gill-raker at angle –	18 – 27	19 – 23	20 – 34	23 – 42	34 – 42
3rd anal spine * –	7.0 – 9.6	4.9 – 7.0	5.2 – 6.7	6.0 – 7.3	6.5 – 7.6
2nd dorsal soft-ray –	5.3 – 6.7	5.7 – 6.0	5.8 – 6.3	6.3 – 6.6	5.9 – 6.7
1st anal spine * –	10.5 –19.3	8.6 –10.3	8.8 –11.2	10.0 –13.1	11.8 –17.5
Orbit length * –	8.4 –10.1	6.6 – 7.1	6.6 – 8.0	7.3 – 7.6	8.4 – 8.5
Total length –	0.78– 0.81	0.79– 0.81	0.80– 0.81	0.81– 0.82	0.82– 0.84
4th dorsal spine * –	6.3 – 7.7	5.0 – 5.8	5.6 – 7.4	6.6 – 7.3	7.1 – 7.4
1st anal soft-ray *	5.2 – 6.7	4.7 – 6.0	4.9 – 5.5	4.9 – 5.7	5.3
Anal-fin base –	6.1 – 7.2	6.0 – 8.1	7.2 – 8.9	7.6 – 8.5	7.5 – 7.6
Pelvic-fin length –	4.5 – 5.2	4.2 – 5.0	4.5 – 5.4	4.9 – 5.3	4.9 – 5.2
Predorsal length	2.7 – 3.0	2.7 – 2.8	2.5 – 2.8	2.6	2.6 – 2.7
Pectoral-fin length *	3.6 – 4.3	3.4 – 3.7	3.3 – 3.6	3.4 – 3.7	3.6 – 3.7
Lower peduncle length *	4.5 – 5.1	5.1 – 5.7	4.7 – 5.6	5.2 – 5.5	5.2
Soft-dorsal base	4.1 – 5.0	4.7 – 4.9	4.4 – 5.3	4.6 – 4.9	4.8 – 4.9
Dorsal-fin incision * –	12 – 22	8.9 –11	11 – 17	11 – 15	12 – 14
Caudal-peduncle depth *	8.7–10.3	11.5 –12.6	11.3 –13.0	11.4 –12.2	10.9 –11.7
Upper peduncle length	6.1 – 7.5	6.8 – 7.8	7.0 – 8.0	7.1 – 8.0	7.1 – 7.5
Spinous-dorsal base +	2.7 – 3.0	2.9 – 3.1	2.6 – 2.9	2.6 – 2.8	2.5 – 2.8
Snout length	9.3 –11.4	10.2 –12.4	9.5 –11.9	10.1 –11.4	9.9 –10.7
Prepelvic length	2.4 – 2.7	2.4 – 2.5	2.4 – 2.7	2.4 – 2.7	2.4 – 2.5
Head length *	2.6 – 2.8	2.4	2.3 – 2.5	2.4 – 2.5	2.2 – 2.5
Upper-jaw length	5.5 – 6.3	5.1 – 5.5	4.9 – 5.8	5.0 – 5.3	4.7 – 5.2
Preanal length	1.5 – 1.6	1.4 – 1.5	1.3 – 1.5	1.4 – 1.5	1.4
Body depth * +	2.8 – 3.3	3.0 – 3.1	2.8 – 3.1	2.7 – 2.8	2.6 – 2.8
Head width +	5.1 – 6.5	5.6 – 5.8	5.5 – 5.8	4.8 – 5.2	4.2 – 4.7
Lachrymal width +	36 – 55	40 – 51	35 – 42	38 – 41	31 – 40
Interorbital width *	13 – 16	15 – 19	15 – 20	14 – 17	13 – 15

like, with the anterior one directed forward and both occasionally bifurcate. Tips of posterior anal soft-rays, when depressed, exceed rather than are exceeded by tips of anterior anal soft-rays. Profile of anal slanting slightly posteriorly, rather than being vertical.

Life color of surface juveniles, as quoted from the original description: "Body dark reddish-brown with a yellowish tinge, paler below, the entire body covered with black punctulations and irregular greenish-yellow blotches, the latter especially marked posteriorly. Dorsal fin dark brown, the membranes of the spinous dorsal black, the soft dorsal irregularly blotched with lighter. Caudal fin yellowish-green, without pattern. Pectoral fin brownish, yellow

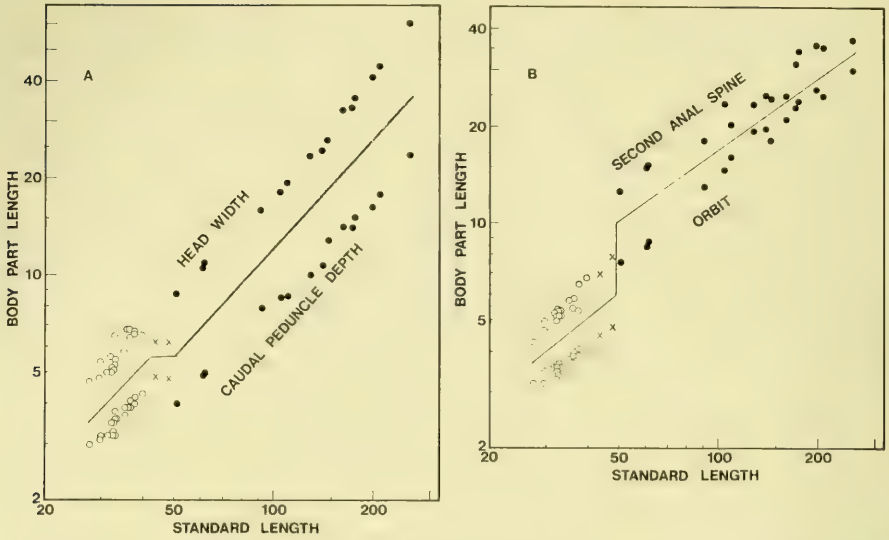

FIGURE 3. A) Head width and caudal peduncle depth and B) second anal spine length and orbit length of *Sebastes peduncularis* (x), and prejuvenile (open circles) and transformed (solid dots) *S. cortezi*.

toward the tip and dusky at the base. Pelvic fins black at base, yellow at tips and with scarlet along the anterior edge. Anal fin black at base, yellow on outer half and with a small scarlet patch at base of the first spine." Specimens in alcohol light brown, with dusky marks in pattern as illustrated (fig. 2d). Peritoneum and oral and gill-cavity linings slightly dusky.

Life color of adults pink, with trace of dusky. Specimens in alcohol pale, with trace of dusky on back, on various fin membranes, and on edge of dorsal. Peritoneum dusky to jet-black. Oral and gill-cavity linings slightly dusky.

For morphometrics and meristics, see tables 4, 7, 8, and 9.

DISCUSSION. In fishes, transition from epipelagic to benthic stages often is associated with a growth infection, resulting in altered body form, as demonstrated in *Pseudupeneus maculatus* by Caldwell (1962) and in *Sebastolobus* species by Moser (1974). The surface-living prejuveniles (28–43 mm.) and the transformed specimens (51–255 mm.) of *Sebastes cortezi* differ markedly in appearance, as is indicated in the species description. In addition, the surface-living prejuveniles have a number of significantly different morphometrics, particularly the heavier caudal peduncle, the smaller eye, and the shorter dorsal and anal spines (table 4, fig. 3). Many of the same differences, however, also exist (personal observation and George Boehlert, personal communication) between epipelagic prejuveniles and benthic forms in *S. diploproa*, a species the adults

of which are most similar to the 15 transformed specimens herein called *S. cortezi*. It is on the basis of the known ontogenetic changes in the closely related *S. diploproa* and the identical meristics (tables 7, 8, and 9) that I consider the 15 specimens to be the older stage of *S. cortezi*.

RANGE. Chen (1971) in giving the range of this species as 26° N., 111° 49′ W. to 29° N., 113° 30′ W., overlooked the type locality and listed the transformed specimens of the species as species "a." The corrected range of *S. cortezi* should be 24° 55′ N., 110° 20′ W. to 29° 43.9′ N., 113° 58.0′ W.

DEPTH. Ten of the 15 transformed specimens examined, including the several largest and the several smallest, were collected by otter or beam trawls at depths ranging from 200–270 to 800–1100 m. The other five specimens (91–160 mm. long), however, were collected with midwater trawls in areas with 1000–1060 and 1400–1700 m. of water. The exact depth of capture of these specimens cannot be determined but presumably they were mesopelagic.

SIZE. The largest male examined measures 255 mm.; the largest female examined, 207 mm. This 207 mm. female was collected on 2 December 1967; its ovary contains large ova.

MATERIAL EXAMINED. A total of 93 specimens.

Surface-living prejuveniles: 78 (15.5–43).

Holotype. CAS SU 46503 (formerly Dept. Trop. Res. N. Y. Zool. Soc. 24889-A), 43.4 mm., taken at surface in weed, at 24° 55′ N., 110° 20′ W., 8 April 1936.

Other specimens. SIO 62-239, 77 (15.5–39.8), 29° N., 113° 30′ W., also taken at surface in weed.

Transformed specimens: 15 (51–255).

SIO 68-89, 2 (61), 29° 43.9′ N., 113° 58.0′ W. to 29° 40.2′ N., 113° 55.4′ W. SIO 68-90, 5 (51–198), 29° 39.5′ N., 113° 55.5′ W. to 29° 43.5′ N., 113° 59′ W. SIO 59-205, 4 (91–139), 28° 45.0′ N., 113° 03.4′ W. LACM 33939-1, 2 (144–207), 28° 38′ N., 113° 00′ W. to 28° 33′ N., 112° 50′ W. LACM 30065-6, 1 (160), 28° 35′ 26″ N., 112° 52′ 56″ W. to 29° 03′ 00″ N., 113° 21′ 30″ W. LACM 8837-3, 1 (255), 26° 59.1′ N., 111° 48.9′ W.

Sebastes varispinis Chen, new species.

(Figure 2a.)

DIAGNOSIS. *Sebastes varispinis* can be differentiated from all other eastern North Pacific species of *Sebastes* by the following combination of characters: (1) the cranial spine pattern (with sharp nasal, preocular, postocular, tympanic, parietal, occasionally nuchal, and, rarely, coronal spines); (2) presence of frontal ridges; (3) the meristics (D. XII–XIII, 11–12 (11–13); A. III, 5–6 (5–7); P_1 18 (17–19); rakers on first gill-arch 29–33); (4) slightly protruding lower jaw; (5) small eyes (orbit 8.4–10.0 in S. L. in 33–53 mm. specimens); (6) slender caudal peduncle (peduncle depth 10.3–11.6 in S. L. in 33–53 mm. speci-

mens); (7) the oral and the gill-cavity linings black; and (8) a color pattern as illustrated (fig. 2a).

Although the present species description is based on juveniles and no adults are known, the black oral and gill-cavity linings and the protruding lower jaw (two characters that are believed to persist into the adult stage), together with the tendency for reduction of the number of dorsal spines from 13 to 12, and the ctenoid rather than cycloid scales will differentiate adults of this species from those of other species of *Sebastes* in the Gulf.

Description. D. XII–XIII, 11–12 (11–13); A. III, 5–6 (5–7); P_1 18 (17–19); C. 14; rakers on first gill-arch 29–33 (8–10 + 20–23); lateral-line pores 37–44; pyloric caeca (in 2 specimens) 9; vertebrae (in 32 specimens) 26 (11 + 15).

Base of skull straight. Interorbital divided by frontal ridges into three shallow grooves. Nasal, preocular, postocular, tympanic, parietal, occasionally nuchal, and rarely coronal spines present, sharp, and moderately strong; many of the specimens have pterotic spines although this is probably a juvenile characteristic (Moser, 1972). Parietal ridges well developed and elevated. Lower edge of gill-cover spineless. Upper four preopercular spines directed backward, lowermost preopercular spine directed downward and often more widely spaced. Lachrymal projections two, spinelike, directed downward and backward. Supracleithral, cleithral, and the two opercular spines well developed.

Symphyseal knob inconspicuous. Tip of lower jaw projecting beyond that of upper. Maxillary reaching to between verticals from mid-orbit and posterior margin of pupil.

Scales ctenoid, many of the specimens examined have scales with a single spine. Mandibles, maxillaries, branchiostegals, and the head before eyes scaleless; head scaled elsewhere.

Dorsal spines increasing in length to 4th or 5th, then decreasing gradually to 11th, 12th spine often slightly longer than 11th, 13th spine nearly twice as long as 11th; soft dorsal high, with the short posterior rays when depressed reaching to near midpoint of caudal peduncle. Second anal spine stronger and longer than third, its tip nearly reaching to tip of first anal soft-ray when depressed; tips of posterior anal soft-rays, when depressed, sometimes exceeded by tips of anterior anal soft-rays. Profile of anal nearly vertical. Caudal truncate. Origin of pectoral below 2nd to 4th dorsal spine; margin of pectoral fin rounded, 8th to 11th rays longest; tip of pectoral extending to anus. Origin of pelvic below 3rd and 4th dorsal spines; tip of pelvic reaching to three-fourths to four-fifths of the length of the pelvic-to-anal distance. Origin of anal below 3rd or 4th dorsal soft-ray, insertion of anal below 9th to 11th dorsal soft-ray.

Extrinsic gas-bladder muscles (2 specimens examined) as in *S. exsul*, except that each muscle splits into only two instead of three tendons and these insert respectively on the parapophyses of the 9th and 10th centra.

Specimens in alcohol light brown, with dusky to black patches on body and various fins (fig. 2a). Pectoral and caudal membranes clear. Peritoneum jet-black. Oral and gill-cavity linings black.

For morphometrics and meristics, see tables 1, 7, 8, and 9.

Etymology. The name *varispinis*, from the Latin, refers to the variation in the number of dorsal spines.

Material examined. A total of 61 specimens, 33–56 mm., all juveniles collected with midwater trawls between surface and 500 m. (bottom at 1400 m.).

Holotype. LACM 8821-11, 49 mm., 28° 58′ N., 113° 11.4′ W.

Paratypes. LACM 8821-8, 60 (33–56) collected with the holotype.

Sebastes peduncularis Chen, new species.

(Figure 2e.)

Diagnosis. Juveniles of *S. peduncularis* can be differentiated from those of other eastern North Pacific species of *Sebastes* by the following combination of characters: (1) the cranial spine pattern (with sharp nasal, preocular, postocular, tympanic, and parietal spines); (2) the meristics (D. XIII, 12–13; A. III, 6; P_1 18; rakers on first gill arch 29–30); (3) presence of frontal ridges; (4) subequal jaws; (5) small eyes (orbit length 8.0–10.0 in S. L. in 43–47 mm. specimens); (6) deep caudal peduncle (peduncle depth 9.0–10.0 in S. L. in 43–47 mm. specimens); (7) narrow body (head width 7.1–7.7 in S. L. in 43–47 mm. specimens); and (8) a color pattern as illustrated (fig. 2e).

Description. D. XIII, 12–13; A. III, 6; P_1 18 (17–18); C. 14; rakers on first gill arch 29–30 (8–9 + 21); lateral-line pores 39–43; vertebrae (in 2 specimens) 26 (11 + 15).

Base of skull straight. Interorbital slightly concave, divided by frontal ridges into three concave grooves. Nasal, preocular, postocular, tympanic, and parietal spines present, sharp, and moderately strong. Parietal ridges well developed and elevated. Lower edge of gill cover spineless. Upper four preopercular spines directed backward, lowermost preopercular spine directed downward and spaced wider. Lachrymal projections two, sharp but not spinelike. Supracleithral, cleithral, and the two opercular spines well developed.

Symphyseal knob inconspicuous; jaws subequal. Maxillary reaching to beyond vertical from posterior margin of pupil.

Scales ctenoid, with 2–3 ctenii on the scales of both specimens.

Dorsal spines increasing in length to 4th, then decreasing gradually to 11th, 12th spine nearly as long as 11th, 13th spine longer than 12th; soft dorsal high, with the short posterior rays when depressed reaching to near midpoint of caudal peduncle. Second anal spine stronger and longer than third, its tip reaching to about three-fourths the length of first anal soft-ray when depressed; tips of posterior anal soft-rays, when depressed, exceed tips of anterior soft-rays. Profile of anal slanting somewhat posteriorly. Origin of pectoral below 3rd dorsal spine;

Table 5. *Morphometrics (standard length, body part measurement) and meristics ("*" signifies left count and right count) of* Sebastes peduncularis.

Character	Paratype LACM 8818-11	Holotype LACM 8818-6
Standard length	48.0	44.0
Morphometrics:		
2nd anal spine	6.1	6.3
Gill-raker at angle	25	24
3rd anal spine	7.4	7.1
2nd dorsal soft-ray	6.2	5.3
1st anal spine	13.0	12.6
Orbit length	10.0	9.8
Total length	0.84	0.79
4th dorsal spine	6.9	6.5
1st anal soft-ray	5.8	5.9
Anal-fin base	6.7	6.3
Pelvic-fin length	4.8	4.6
Predorsal length	3.1	2.9
Pectoral-fin length	4.2	3.9
Lower peduncle length	5.1	4.9
Soft-dorsal base	4.7	5.2
Dorsal-fin incision	16	13
Caudal-peduncle depth	10.0	9.0
Upper peduncle length	7.6	6.1
Spinous-dorsal base	3.0	2.9
Snout length	12.0	11.6
Prepelvic length	2.6	2.6
Head length	2.8	2.7
Upper-jaw length	6.9	6.1
Preanal length	1.48	1.49
Body depth	3.0	3.0
Head width	7.7	7.1
Lachrymal width	60	55
Interorbital	15.5	14.2
Meristics:		
Lateral-line pores *	43–40	39––
Dorsal soft-rays	13	12
Pectoral rays *	18–18	18–17
Anal soft-rays	6	6
Gill-rakers *	30–30	29–29

margin of pectoral fin rounded, 10th ray longest; tip of pectoral extending to near anus. Origin of pelvic below 4th dorsal spine; tip of pelvic reaching to two-thirds the length of the pelvic-to-anal distance. Origin of anal below 3rd or 4th dorsal soft-ray, end of anal below 10th or 11th dorsal soft-ray.

Specimens in alcohol light brown with faint marks in pattern as illustrated (fig. 2e). Peritoneum dusky. Oral and gill-cavity linings slightly dusky.

For morphometrics and meristics, see tables 5, 7, 8, and 9.

Discussion. Considering the morphological changes involved in metamorphosis from the surface-living prejuvenile stage to the juvenile stage in *S. cortezi*, it is very difficult to establish the validity of *S. peduncularis* without a series of specimens of different sizes. Meristics do not differentiate this form from *S. cortezi*, *S. varispinis*, or *S. sinensis*. The two specimens of *S. peduncularis* agree with prejuveniles of *S. cortezi* in having short dorsal and anal spines and pectoral fins, small eyes and head, deep caudal peduncle, and broad interorbital (fig. 3); and agree with transformed juveniles of *S. cortezi* in having frontal ridges and sharp cranial and fin spines. These two specimens are intermediate in size between specimens of *S. cortezi* of the the two contrasting stages. Since the two specimens were captured in a midwater trawl and as they show only a trace of the dark vertical bands characteristic of surface-living juveniles, they probably were in the process of transforming to the juvenile stage. However, although the two specimens have a mixed combination of the prejuvenile and juvenile characteristics of *S. cortezi*, none of the characteristics are intermediate between the two stages. That the two specimens of *S. peduncularis* are specifically distinct from *S. cortezi* is suggested by their characteristic color pattern (fig. 2e) not intermediate between the two stages of *S. cortezi*, by their narrow head (fig. 3), and by the dorsal soft-ray count of 13 and the gill-raker count of 30 in the paratype, two rather unusual counts for *S. cortezi*.

The distinction between *S. peduncularis* and *S. varispinis* is much more apparent, as the specimens of the two species available are probably in a similar stage of development. Compared with juveniles of *S. varispinis*, the two specimens of *S. peduncularis* have shorter fin spines, gill-rakers, and pectoral fins; deeper caudal peduncle and body; and much lighter pigmentation in the gill cavity and oral linings. Furthermore, they lack the protruding lower jaw of *S. varispinis*.

From *S. sinensis*, *S. peduncularis* can be distinguished by having ctenoid rather than cycloid scales.

Etymology. The name *peduncularis*, from the Latin, refers to the deep caudal peduncle of this species.

Material examined. Only two specimens are known.

Holotype. LACM 8818-6, 43 mm., juvenile, collected with midwater trawl from 28° 55′ N., 112° 50.5′ W., midway between southern tip of Tiburon Island and Angel de la Guarda Island, the water depths were 440–450 m. and the trawl was operated between bottom and surface (Lavenberg & Fitch, 1966).

Paratype. LACM 8818-11, 47 mm., collected together with the holotype.

Sebastes macdonaldi (Eigenmann & Beeson).

(Figure 1a.)

Sebastodes proriger (not of Jordan & Gilbert): Eigenmann & Eigenmann, 1890, p. 15 (description).

Acutomentum macdonaldi Eigenmann & Beeson, 1893, p. 669 (type locality: San Diego). Jordan, Evermann, & Clark, 1930, p. 366 (name only).

Sebastodes macdonaldi: Cramer, 1895, p. 594 (species analysis). Jordan & Evermann, 1898, p. 1786 (species analysis, description). Phillips, 1957, p. 90 (key, description, range, depth, size).

Sebastes macdonaldi: Chen, 1971, p. 75 (range). Moser, 1972, pp. 941–958 (development, distribution).

Diagnosis. The presence of a spine on the lateral surface of lachrymal (in specimens larger than 10 cm.) and three or four spines on the lower edge of lachrymal and the high lateral-line pore count (> 50) differentiate this species from all other species of *Sebastes*.

Description. D. XIII, 13 (12–14); A. III, 7; P_1 19 (18–20); C. 14; rakers on first gill-arch 36–42 (10–13 + 25–29); lateral-line pores 52–58; pyloric caeca (in 3 specimens) 8–11; vertebrae (in 12 specimens) 26 (12 + 14).

Base of skull straight. Interorbital flat in juveniles, slightly convex in adults, without frontal ridges. Nasal, preocular, postocular, tympanic, parietal, and frequently supraocular (nearly 50%) and nuchal (nearly 30%) spines present, sharp, and moderately strong but recumbent. Parietal ridges well developed, low. Lower edge of gill-cover spineless. Preocular spines equally spaced, the two upper ones directed backward, the three lower ones downcurved. Lachrymal projections three or four, spinelike; lateral surface of lachrymal with a retrorse spine above the second lachrymal projection near edge of orbit in specimens longer than 10 cm. Upper edge of second suborbital with a small spine in specimens less than 5 cm. Supracleithral, cleithral, and the two opercular spines well developed.

Symphyseal knob conspicuous and directed forward in juveniles, inconspicuous in adults; lower jaw definitely projecting, entering dorsal profile of head. Maxillary ending behind vertical from posterior edge of pupil but before margin of orbit.

Scales ctenoid, small. Head fully scaled, with the exception of the lips. Fin rays scaled; membranes scaled basally, most extensively on anal and caudal.

Dorsal spines increasing in length to 4th, then decreasing gradually to 12th, 13th spine longer than 12th; soft dorsal high, with the short posterior rays when depressed reaching to only about one-third the distance between dorsal insertion and caudal base. Second anal spine shorter than 3rd, tip of 3rd spine reaching to about one-fifth (large specimens) to one-half (small specimens) the length of first anal soft-ray when depressed; tips of posterior anal soft-rays reaching to about one-third the distance between anal insertion and caudal base, exceed-

TABLE 6. *Morphometrics of* Sebastes macdonaldi. "*" signifies significant difference *(Analysis of covariance, $P < .005$) between the Gulf and the outer coast samples. Other explanations as table 1.*

		Outer coast					Gulf
Character	size range mm. / no.	55–85 / 6	145–238 / 9	275–319 / 6	379–396 / 2	476–513 / 3	135–227 / 7
2nd anal spine * –		6.9 – 8.9	8.9 –10.9	10.6 –13.8	13.1 –15.5	13.0 –15.7	7.7 –10.2
Gill-raker at angle –		17 – 20	18 – 22	18 – 27	24 – 29	20 – 43	18 – 20
3rd anal spine * –		7.9 – 9.3	8.8 –10.5	10.7 –12.7	12.0 –13.5	12.5 –13.0	7.5 – 9.5
2nd dorsal soft-ray		6.2 – 7.9	6.7 – 8.3	6.9 – 7.9	6.8 – 7.1	7.0 – 7.9	6.8 – 8.1
1st anal spine * –		11 – 18	16 – 23	18 – 23	22	21 – 28	13 – 23
Orbit length –		8.8 – 9.6	8.3 –10.3	9.4 –10.4	10.9 –11.1	11.2 –11.7	8.6 – 9.4
Total length –		0.79– 0.82	0.81– 0.84	0.81– 0.84	0.82– 0.84	0.79– 0.83	0.81– 0.85
4th dorsal spine –		6.0 – 6.7	7.2 – 8.5	7.3 – 9.4	7.8	7.5 – 8.1	6.7 – 7.3
1st anal soft-ray		5.5 – 6.7	6.4 – 7.6	6.1 – 6.8	5.7 – 6.7	6.0 – 6.4	6.1 – 6.8
Anal-fin base –		6.7 – 7.0	7.0 – 8.1	7.9 – 8.3	7.4 – 8.0	7.8 – 8.1	7.3 – 7.9
Pelvic-fin length –		4.4 – 5.0	5.1 – 5.6	5.3 – 5.5	5.0	5.2 – 5.6	5.1 – 5.6
Predorsal length		2.8 – 3.0	2.8 – 2.9	2.8 – 3.0	2.8 – 2.9	2.9	2.8 – 2.9
Pectoral-fin length –		3.1 – 3.9	3.5 – 4.1	3.8 – 3.9	3.6 – 3.8	3.8 – 4.0	3.5 – 3.8
Lower peduncle length		5.0 – 5.5	4.8 – 5.5	5.0 – 5.9	4.9 – 5.0	5.2 – 5.6	5.0 – 5.3
Soft-dorsal base +		4.6 – 5.1	4.6 – 5.4	5.0 – 5.4	5.1 – 5.2	4.9 – 5.3	4.7 – 5.7
Dorsal-fin incision		13 – 21	14 – 19	14 – 22	17 – 18	13 – 20	15 – 19
Caudal-peduncle depth +		11 – 13	12 – 14	12 – 13	12	11 – 12	12 – 14
Upper peduncle length		6.5 – 7.9	6.5 – 7.4	5.2 – 6.7	6.4 – 7.0	6.9 – 7.0	6.5 – 7.6
Spinous dorsal base +		2.8 – 3.0	2.7 – 3.0	2.7 – 2.8	2.6 – 2.9	2.6 – 2.8	2.5 – 2.9
Snout length +		10 – 12	11 – 12	10 – 12	10	9.2 –10.0	10.4 –11.3
Prepelvic length		2.4 – 2.6	2.5 – 2.8	2.4 – 2.5	2.5 – 2.6	2.4 – 2.5	2.4 – 2.5
Head length +		2.4 – 2.7	2.4 – 2.5	2.4 – 2.6	2.4 – 2.5	2.4 – 2.5	2.4 – 2.5
Upper-jaw length * +		5.7 – 6.4	5.3 – 5.7	5.3 – 5.5	5.2 – 5.3	5.2 – 5.3	5.1 – 5.4
Preanal length +		1.4 – 1.5	1.4 – 1.5	1.4	1.4	1.3 – 1.4	1.4 – 1.5
Body depth +		3.1 – 3.2	3.0 – 3.3	2.9 – 3.3	2.9 – 3.0	2.8 – 2.9	2.8 – 3.2
Head width +		6.0 – 7.2	5.5 – 6.6	5.2 – 6.5	5.7 – 6.1	4.9 – 5.8	5.5 – 6.5
Lachrymal width +		43 – 62	36 – 42	31 – 37	27 – 29	28 – 30	35 – 41
Interorbital width +		13 – 14	13 – 15	13 – 14	12	12	13 – 14

ing tips of anterior anal soft-rays when fin depressed. Profile of anal slightly slanting posteriorly. Caudal slightly forked. Origin of pectoral below 3rd or 4th dorsal spine; pectoral pointed; 10th or 11th ray longest; pectoral extending to beyond tip of pelvic, with tip reaching to anus in small specimens but not in large specimens; origin of pelvic below 3rd to 4th dorsal spine; tip of pelvic extending to one-half (large specimens) to three-fourths (small specimens) of pelvic-to-anal distance; origin of anal below 2nd to 3rd dorsal soft-ray, insertion of anal below 10th to 11th dorsal soft-ray.

Extrinsic gas-bladder muscles (2 specimens examined) as in *S. exsul*, except that each muscle splits into four tendons which insert respectively on parapophyses 6, 7, 8, and 9.

Color in life chocolate brown on back, grading to dull red beginning from below the conspicuous light lateral line. Cheek with three oblique dark bands, one behind eye, one below eye, and one on posterior part of maxillary. Dorsal and caudal fin membranes wholly dark brown; pectoral membrane black, mixed with trace of red; pelvic and anal membranes red, with trace of black. Peritoneum black. Oral and gill-cavity linings slightly dusky. Juveniles smaller than 10 cm. have conspicuous dark vertical bands on body in pattern similar to that of the other species illustrated in figure 2.

For morphometrics and meristics, see tables 6, 7, 8, and 9.

Range. *S. macdonaldi* occurs from 36° 18′ N., 122° 04′ W. to 23° 24.0′ N., 111° 11.5′ W. along the outer Pacific coast (Chen, 1971) and from 26° 59.1′ N., 111° 48.9′ W. to 28° 58′ N., 113° 11.4′ W. in the Gulf of California (Moser, 1972). It is the only species of *Sebastes* known to occur both inside and outside the Gulf of California. Chen (1971) suggested that the distribution of the species may be continuous around the tip of Baja California. A comparison made between materials from the two sides of Baja California (tables 6, 7, 8, and 9), however, discloses significant differences in a number of characters. The Gulf sample has longer lower jaw and anal spines ($p << 0.005$, analysis of covariance) and a higher frequency of 20 pectoral rays and 12 dorsal soft-rays ($p < 0.01$, Chi-square test). These suggest isolation of the two populations.

Depth and size. Phillips (1957) gave the maximum depth for the species as 65 fms. (130 m.) and (1968) the maximum size for the species as 26 in. (≃ 53 cm. S. L.). I herein report a new depth record of 350 m. (SIO 65-64).

Material examined. A total of 84 specimens, 33-532 mm.

Gulf of California. LACM 8821-9, 6 (33–46); LACM 8837-4, 1 (227); SIO 73-1, 3 (135–176); SIO 73-2, 3 (174–180).

Outer coast. SIO 54-153, 2 (310–318); SIO 65-126, 4 (478–532); SIO 65-194, 8 (272–322); SIO 65-217, 9 (258–316); SIO 65-227, 11 (60–72); SIO 65-230, 2 (385–405); SIO 68-5, 1 (307); SDSC 72-52, 1 (85); SDSC 72-30, 33 (145–238).

TABLE 7. *Pectoral-ray, dorsal-soft-ray, and anal-soft-ray counts of the rockfishes of the Gulf of California.*

	Pectoral (left + right)								Dorsal soft-rays				Anal soft-rays			Dorsal spines			
	33	34	35	36	37	38	39	40	11	12	13	14	5	6	7	12	13	14	15
S. spinorbis		1		3							3	1		4			4		
S. exsul	2	29	3	2						18	18		3	32			35		1
S. macdonaldi																			
Gulf						7	2	4		5	5	2			12		12		
Outer coast				1	3	34	7	1		4	37	3		2	42	2	41	1	
S. cortezi																			
Prejuveniles		3	4	12	1					4	16			5	15		1	20	
Older stages			2	7	4	2				3	12			1	14			15	
S. sinensis	2	6	52	5	2					41	26	1		24	43	1	3	62	3
S. varispinis	2	3	20	1	2					17	29	2		10	37	1	10	38	
S. peduncularis		1	1								1	1			2			2	

TABLE 8. *Total gill-raker counts (left + right) of the rockfishes of the Gulf of California.*

	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
S. spinorbis					1			1		1		1																	
S. exsul										1	4	5	8	6	3	4	2	2		1									
S. macdonaldi																													
Gulf																				1	5	2	1	2					
Outer coast																				1	7	15	11	5	2	3	1	0	1
S. cortezi																													
Prejuveniles	1	1	7	3	5	3																							
Older stages	2		4		2	2	3	1	1																				
S. sinensis					3	7	11	12	20	7	4	3	1																
S. varispinis					2		2	8	10	2	3		1																
S. peduncularis					1		1																						

TABLE 9. *Lateral-line-pore counts (left + right) of the rockfishes of the Gulf of California.*

	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
S. spinorbis	1					1			1					1										
S. exsul			3	1			3	3	5	5	4	4	4		2			1						
S. cortezi																								
Prejuveniles					1					1	2			4	2	3	3	1	1					
Older stages		1								1		1		2	4						1			
S. sinensis								1	2	3	2	7	1	7	3	3	2	1	3	1				1
S. varispinis										1	4			1	2		1	1						
S. peduncularis																1								

	105	106	107	108	109	110	111	112	113	114	115	116
S. macdonaldi												
Gulf			1	1			2			1		
Outer coast	1	1	1	3	1	6	3	1	3	1		1

Relationships, Zoogeography, and Speciation

Although at least seven species of *Sebastes* have been recognized there, with but a few exceptions their known occurrence in the Gulf of California is restricted to the area between 27° N. and 30° N., centering around the vicinity of Canal de las Ballenas west of Isla Angel de la Guarda and Isla Tiburón (fig. 4). Within this area, however, some of the species, such as *S. macdonaldi*, occur in great abundance, as is found in the catches of the 1972 FAO Hake Resource Survey of the *Alejandre Humboldt* (AH 72-03, David Kramer, personal communication). Walker (1960) listed a number of temperate species restricted to, or most common in, this area.

This pattern of distribution seems to be related to the distribution of water temperature and dissolved oxygen in the Gulf of California. At the tip of Baja California there is an oceanic front, at times with a sharp temperature gradient of from 20° C. in the northwest to 27° C. in the southeast across a distance of only one degree of latitude (Cromwell & Reid, 1956; Griffiths, 1965; and Reid *et al.*, 1958). As the warmest water in which pelagic *Sebastes* larvae have been found is 18.08° C. (CCOFI 5604, 127G. 40, Scripps Inst., Oceanogr., 1963; Oceanic observations of the Pacific, 1956), this oceanic front forms a surface barrier probably not transgressible by *Sebastes*. The surface temperature southeast of the front fluctuates seasonally, with a minimum consistently above 18° C. This condition usually extends northward into the Gulf, with the exception of the vicinity of Canal de las Ballenas where the winter surface temperature (14° C.) is significantly lower, probably caused by the strong local tidal mixing (Roden, 1964). This appears to be the only area in the Gulf where conditions favor the survival of *Sebastes* during their pelagic juvenile stage.

Although most parts of the Gulf have surface water too warm for *Sebastes*, adults of *Sebastes* capable of submerging should find suitable temperatures at depth from Ballenas Channel to the south. South of a submarine ridge south of the Ballenas Channel, however, an oxygen-minimum layer extends in from the North Pacific between 200 m. and 1000 m., with an oxygen concentration of from 0.5 ml./l. to as low as < 0.1 ml./l. (Roden, 1964), lower than the lethal limit for most of the fishes as compiled by Doudoroff and Shumway (1970). This makes deep-water transgression from the outer coast into the upper Gulf also a difficult task for *Sebastes*. The only area in the Gulf with habitats favorable to *Sebastes* is thus the vicinity of Ballenas Channel where surface water is cold enough in the winter to allow a successful pelagic life for the larvae and where at depth (150–600 m.) the temperature is probably low enough (12–16° C.) throughout the year for the adults, and the oxygen level (> 1.0 ml./l.) is adequate.

The high surface temperature and the oxygen-minimum layer in deep water in the south not only limit the distribution of *Sebastes* in the Gulf but probably also create a dispersal barrier contributing to speciation in *Sebastes*. Recent

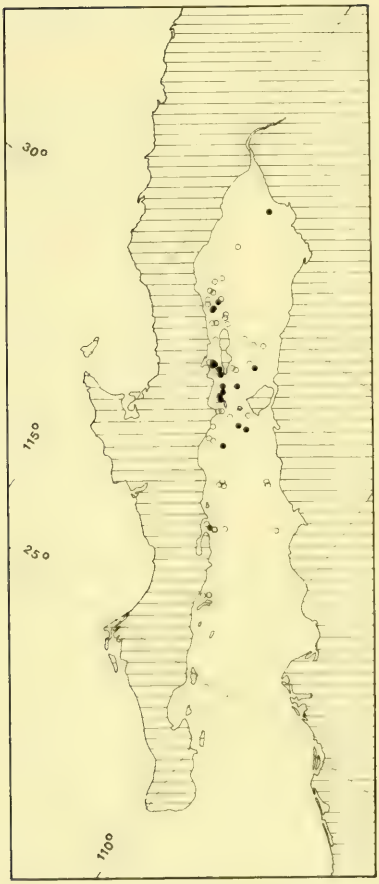

Figure 4. Distribution of *Sebastes* in the Gulf of California. Open circles: surface collections, included are a number of collections from CCOFI (courtesy of H. G. Moser) and UCLA not listed in this report. Solid dots: mesopelagic or benthic collections.

geological studies (Larson, 1972; and Elders *et al.*, 1972) suggest that the Gulf of California originated about four million years ago as a result of northwestward rifting of Baja California and southern and central California along the San Andreas Fault. The first successful invasion of the Gulf by *Sebastes* was apparently a much more recent event, after the development of an area in the Gulf such as the present Ballenas Channel, with conditions favorable to *Sebastes* and during a period of oceanic cooling allowing surface transgression (rather than bottom, assuming the oxygen-minimum layer has existed since the origin of the Gulf). Repeated Pleistocene glaciation is an apparent mechanism providing opportunities for such invasion from the outer coast into the Gulf and the reciprocal events, contributing to the diversity of *Sebastes* both inside

and outside the Gulf. An analysis of the relationships among the species will shed some light on the history of such events.

The seven species in the Gulf seem to represent three sets of species. *S. macdonaldi* is an independent lineage and is represented also by population(s) in the outer Pacific waters. The low degree of differentiation of the population of this species in the Gulf from its parental population(s) on the outer coast suggests that the present disjunction in distribution originated rather recently. *S. macdonaldi* is the species of *Sebastes* with the southernmost known limit (23° 24.0′ N.) (Chen, 1971).

The other six species are all Gulf of California endemics. Of the six, *S. exsul* and *S. spinorbis* form a pair, with vermiculations and or dusky marks on the back and with dusky scale margins characteristic of the *umbrosus-lentiginosus* and the *chlorostictus-rosenblatti-cos* complexes of the subgenus *Sebastomus* recently reviewed by Chen (1971). The close relationship between *S. exsul* and *S. umbrosus* is also supported by the identical hemoglobin electropherograms demonstrated by Sharp (1973). At the present, off southern California, *Sebastomus* is represented by four sets of species (*constellatus*, *rosaceus-helvomaculatus-simulator*, *ensifer-notius*, and *umbrosus-lentiginosus-chlorostictus-rosenblatti-cos*, three of which contain shallow water species (*constellatus*, *rosaceus*, and *umbrosus*) which are more likely to accomplish surface transgression. The present number of species in these species groups suggests that group divergence is not a very recent event. The *exsul-spinorbis* pair does not represent a separate species group but rather belongs to one of the four sets, suggesting that this lineage was distinct prior to the invasion of the Gulf. *Sebastes exsul* and *S. spinorbis* seem more similar to each other than to any other species outside the Gulf, suggesting that the two had a common immediate ancestor. This, if true, would suggest that this lineage represents a single invasion of the Gulf, and thus, the divergence of the two species took place in the Gulf after the invasion. It is interesting to note that the *S. capensis* complex in the southern hemisphere also shares with the *umbrosus-cos* complex the characteristic vermiculations or dusky marks on the back and the dusky scale margins. Although it is possible that the *exsul-spinorbis* and the *capensis* complexes have the same origin, and that successful invasion of the Gulf and crossing of the tropics by *Sebastomus* were accomplished by the same ancestor species using the same climatic event, multiple crossings cannot be ruled out.

The four remaining species are related to the eleven species that I regard as comprising the subgenus *Allosebastes* Hubbs, 1951, namely *S. diploproa*, *S. saxicola*, *S. semicinctus*, *S. dallii*, *S. zacentrus*, *S. wilsoni*, *S. emphaeus*, *S. variegatus*, *S. rufinanus*, and *S. proriger* of the outer coast and *S. scythropus* of the western North Pacific. Shared characters are nasal, preocular, postocular, tympanic, parietal, and occasionally nuchal spines present; a characteristic banded color pattern (fig. 2), at least during the juvenile stage of their life

(except perhaps *S. scythropus*), and a pair of extrinsic gas-bladder muscles which originates near the opisthotic, passes medial to the cleithrum to which it has a membranous connection, then each member of the pair splits typically into two or three tendons which pass between the second and third ribs, run straight along the inner side of succeeding ribs, and insert respectively on the parapophyses of the 8th to 10th centra, without any direct connection between the tendons and the gas-bladder wall.

Of these four species, *S. cortezi* and *S. sinensis*, which together with *S. diploproa* of the outer coast form a species group, all have rather similar body configuration, large eyes, uniformly red body with some dusky on back, and epipelagic juveniles charcterized by blunt cranial spines. In this group, *S. cortezi* and *S. diploproa* may be called a species pair; both have anteriorly-directed lachrymal projections (not found in any other species of *Allosebastes*), and both have extra tendons in the extrinsic gas-bladder muscles in addition to the typical *Allosebastes* pattern. *S. sinensis* probably is the species bridging the gap between the *cortezi-diploproa* pair and the closest species of the outer coast, probably *S. saxicola*.

The affinities of the two remaining species, *S. varispinis* and *S. pedunculatis*, cannot be ascertained but they both are definitely close to the *sinensis-diploproa-cortezi* complex. It is clear that the history of the four species of *Allosebastes* in the Gulf is more complex than that of the two referred to *Sebastomus*, and suggests a possible multiple invasion of *Allosebastes* species from the outer coast into the Gulf, either by the same ancestral stock at different periods, or by different parental species either simultaneously or not; after successful invasion(s), it appears that radiation took place in the Gulf and there probably was (were) successful reciprocal invasion(s) from the Gulf to the outer coast, as suggested by the *cortezi-diploproa* pair.

The relationships and zoogeographic history outlined above are very speculative. If further studies support the hypothesis that species differentiation took place within a limited area in the Gulf, it would suggest that speciation in *Sebastes* does not necessarily require the presence of a geographic barrier. This helps to explain the origin of the high diversity of *Sebastes* in the North Pacific, with approximately 100 species, most of which are extensively sympatric (Chen, 1971).

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